
MARINE
BIOLOGY

Macrobenthos of the Ob River Estuarine Zone and of the Adjacent Regions of the Kara Sea

S. V. Galkin, N. V. Kucheruk, K. V. Minin, A. K. Rayskiy, and E. I. Goroslavskaya

Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russia

E-mail: galkin@ocean.ru

Received September 12, 2008; in final form, June 15, 2009

Abstract—The composition and distribution of the macrobenthic communities in the Ob estuary and the adjacent Kara Sea shelf were studied during the 54th cruise of the R/V *Akademik Mstislav Keldysh*. With the transition from the Ob River's mouth to the open parts of the sea, the gradual changes of the bottom biocenoses included changes in the leading taxa. Along with the increase in the salinity, the freshwater and brackish water taxa are replaced by related forms adapted to dwelling in seawater. The comparison of the original data with the results of the previous investigations revealed considerable spatial and temporal variations of the bottom communities in the studied area. The main environmental factors determining the fauna distribution in the estuarine zone are discussed. The extensive biocenosis dominated by *Portlandia aestuariorum* in the Ob estuary was found for the first time.

DOI: 10.1134/S0001437010050152

INTRODUCTION

The Ob River's mouth and the adjacent area of the Kara Sea are regions of special interest regarding the assessment of the impact of the frontal processes on the parameters of the aquatic ecosystem. The bottom fauna is the most conservative component of this ecosystem and, as opposed to pelagic communities, may reflect some integral characteristics of the generally unstable environment. The rate of the development of the bottom communities is relatively low, and the composition and distribution of the bottom organisms (as well as of their remains) allow for the assessment of the scales of the seasonal and long-term changes occurring in the region under impact of the powerful riverine discharge.

More or less regular studies of the part of the benthos of the Kara Sea shelf adjacent to the Ob's mouth have been carried out since the 1920s (research trips aboard the *Persei*, *Sibiryakov*, and other ships). The results of these studies have been published in many papers [2–7]. Our studies aboard the R/V *Dmitri Mendeleev* (1993) revealed the presence of considerable differences in the composition and distribution of the bottom communities in this region compared to the data obtained earlier [1]. However, the nonrecurrent studies do not allow judging whether such changes are of directed or cyclic character.

The goal of the present paper is to study the distribution of the macrobenthos communities in the Ob River's estuary and the adjacent regions of the Kara Sea's inner shelf and to reveal the environmental factors determining this distribution. The following specific tasks were pursued: the sampling of representative

material at stations located from the Ob's estuary to the open areas of the sea, the revealing of the dominating taxa of the bottom communities and the comparison of this material with the data on the environmental factors at the same stations, the comparison of the newly obtained data with the results of the previous studies in this region.

MATERIALS AND METHODS

The material was sampled in September 2007 at eight sampling stations along the submeridional transect from 71°44'N to 75°33'N at depths ranging from 11 to 160 m (table). Four samplings were carried out in the Ob's estuary and four at the adjacent shallow shelf. A Sigsby trawl with a 1.5 m × 35 cm steel frame was used for the sampling. The trawl was equipped with a double sack: the outer sack with a 45 mm mesh size and the inner sack with 4.0 mm mesh. The samples were washed on a system of steel sieves with 5 mm and 1.0 mm mesh. If necessary, additional washing using the method of consecutive stirring up using a hand sieve with a 0.5 mm mesh was carried out. The samples were initially preserved with neutralized 6% formalin followed by their transfer to 75% ethanol. The large and fragile animals were sampled by hand and preserved separately. The washed ground and stones were passed along to geologists.

RESULTS AND DISCUSSION

The obtained material allows for revealing the main types of biocenoses found based upon the domination

Leading groups of benthos and the environmental factors at the sampling stations

Sta- tions	Coordinates		Depth, m	Leading species of benthos	Environmental factors						
	N	E			ground	C _{org} of the sediments (0–1 cm, %)	layer of water near the bottom				
							C _{org} of the suspension, µg/l	T°, C	S, %	O ₂ , ml/l	pH
4994	71°44'	72°47'	16	<i>Saduria entomon</i>	Large silted aleurites	1.51	1608	6.05	0.855	8.2	7.52
4995	72°10'	73°15'	11	<i>Marenzelleria wireni</i> , <i>Alytus carinatus</i> , Olygochaeta: Tubificidae, <i>Portlandia aestuariorum</i>	Fine aleurite silts	2.39		4.35	8.690	7.13	7.53
4996	72°34'	73°47'	20	<i>Portlandia aestuariorum</i> , <i>Saduria sibirica</i> , <i>Gammaracanthum loricatus</i>	Fine aleurite silts	1.95	1241	2.24	24.443	7.36	7.83
4999	72°57'	73°18'	27	<i>Stegophiura nodosa</i> , <i>Saduria sibirica</i> , <i>Portlandia aestuariorum</i> : <i>Musculus</i> , <i>Macoma</i> , <i>Natica</i>	Fine aleurite silts with a considerable admixture of clay material	0.85	2734	0.09	29.525	6.94	7.86
5000	73°45'	72°57'	24	<i>Portlandia arctica</i> , <i>Saduria sibirica</i> , <i>Saduria sabini</i> , <i>Astarte borealis</i> , <i>Macoma calcarea</i> , <i>Pectinaria hyperborea</i>	Fine aleurite silts with a considerable admixture of clay material	0.03	1253	0.80	32.125	5.64	7.77
5002	75°10'	72°37'	30	<i>Acabthostepheieia behringensis</i> , <i>Diastylis glabra</i> , <i>Portlandia arctica</i> , <i>Nephtis longistosa</i> , <i>Synodothea bicuspidata</i> , <i>Saduria sabini</i>	Well-sorted medium-grain sands			1.15	32.286	6.83	7.92
5003	75°27'	72°31'	60	<i>Ophiocten sericeum</i> , <i>Ohioacantha bidentata</i> , <i>Portlandia arctica</i> , <i>Propeamusium groenlandicus</i> , <i>Saduriasabini</i> , <i>Spiochaetopterus typicus</i> (tubes)	Fine aleurite silts	0.51	440	1.13	32.852	7.03	8.00
5004	75°33'	72°30'	160	<i>Ophiopleura borealis</i> , <i>Nucula tenuis</i> , <i>Ctenodiscus crispatus</i> , <i>Picnogonida</i>	Aleurite–pelite silts			0.96	34.036	7.02	8.02

of certain taxa in their composition. As a rule, such domination is strongly pronounced. Our previous studies in this region [1] revealed that 85% to 99% of the total sample weight was composed of three to four leading taxa. This allows for revealing the dominant and leading taxa in each sample already at the stage of the initial processing of the samples. The data on these taxa and the environmental characteristics are given in the table.

We carried out studies of the distribution of the benthos in the Ob's estuary and the adjacent regions of the Kara Sea earlier during the 49th expedition of the R/V *Dmitrii Mendeleev*. It was noted that, in the studied region, the regular changing (from the south to the north) of three main complexes takes place: 1. the crustaceans *Saduria entomon*, *S. sibirica*, and Amphipoda; 2. the bivalve mollusks *Portlandia*, *Macoma*, and *Astarte*; 3. the echinoderms *Stegophiura nodosa*, *Ophiocten sericeum*, *Urasterias*, and *Ctenodiscus* [7, 1].

The new data have confirmed, in general, the above mentioned regularity. However, the comparison of the new data with the materials of the earlier expeditions revealed the considerable variability of the bottom communities both in space and in time. Such fluctuations can be traced up to the latitude of 73.5°N.

As an example, there is the composition of the fauna at station 4999 of our transect. There, at the water salinity near the bottom of 29.5‰, Ophiuroidea (*Stegophiura nodosa*) and Isopoda were abundant. Earlier, during the *Dmitrii Mendeleev* expedition at the corresponding station (station 4415), the bivalve mollusk *Portlandia* clearly dominated in the community. In the present study, at the above mentioned station, these mollusks were represented only as shell debris. Presumably, in this case, the periodic recolonization of the same biotope takes place and mobile animals (crustaceans and basket stars) are the pioneering colonizers, settling earlier than the slow moving and relatively slowly growing mollusks.

The variability of the estuarine communities may be expressed on different scales: from the mosaicity in the distribution of the populations to the positions of the borders of the biocenotic complexes. In the temporal aspect, the variability may be seasonal or multi-annual. Presumably, the salinity is not the only factor determining the distribution of the populations and communities. According to the available data, the spatial and temporal variability in the communities is evident up to 73.5°N, i.e., till the establishing of relatively high and constant water salinity.

It is obvious now that such variability cannot be described by a simple scheme. To reveal the main regularities of the structure and dynamics of estuarine communities, long-term monitoring is necessary. The data available for us to date allow only for preliminary conclusions and for outlining the general features in the distribution of the leading benthic groups in the studied region.

At the first stations of the transect in the conditions of almost total desalination, the isopods *Saduria entomon* are the dominants in the macrobenthos: the samples collected at these stations are in fact a monoculture of these crustaceans.

Further downstream (at a salinity of 8.7‰), the leading forms include the polychaetes *Marenzelleria wireni*, the oligochaetes Tubificidae, the isopods *Atylus carinatus*, and some echinoderms. At the same station, a large amount of shell debris of *Portlandia aestuariorum* was found, evidencing the possibility of at least periodic mass introductions of these mollusks in this region. Such introductions may result in quite long colonization, since the growth of the mollusks continues for several years.

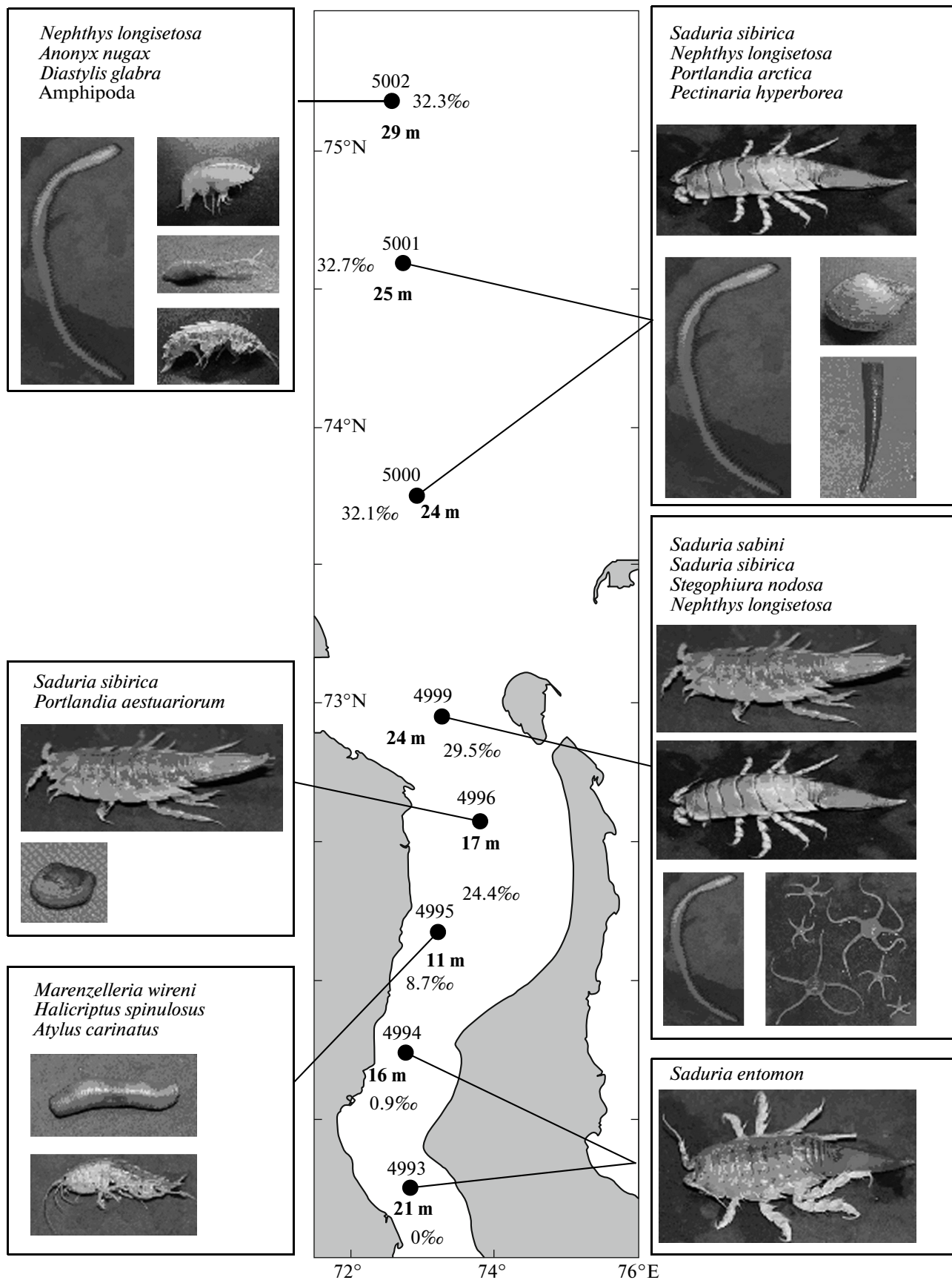
At station 4996 (salinity of 24.4‰) live mollusks are included in the composition of the leading groups. Among the isopods, *Saduria sibirica* and *S. sabini* are the most abundant, substituting for the freshwater *S. entomon*. The species diversity of the community increases sharply. The fauna there is of almost "marine" type.

At station 4999 (salinity of 29.5‰), along with the domination of the euryhaline *Saduria*, representatives of the typically marine fauna and the basket star *Stegophiura nodosa* appear in large numbers. In addition, the holothurians *Chiridota* and the polychaetes *Nephtis longisetosa* were found at this station. At the same station, a decrease in the organic carbon in the surface layer of the sediments is noticeable.

It is worth noting that, near stations 4996–4999, the most substantial changes in the pelagic component of the ecosystem were noted. Presumably, these changes relate to the frontal processes. There, a sharp increase in the mesoplankton biomass above the pycnocline (data by E.G. Arashkevich) was noted along with a decrease in the quantitative indices of the phytoplankton till the level normal for the sea (I.N. Sukhanova).

At the two further stations (5000 and 5001) with almost typical seawater salinity (more than 32‰) and a low C_{org} content in the sediments, the samples are dominated by the bivalves *Portlandia arctica* and sea mollusks substitute for the brackish water *Portlandia aestuariorum*.

In the samples at station 5002 (salinity of 33.8‰), the following species were abundant: amphipods (especially *Acabthostepheieia behringiensis*), Cumaceae (*Dyastylus glabra*), and polychaetes (*Nephtis longistosa*). In addition, the isopod *Syndothea bicuspidata* and the mollusks *Serripes* and *Portlandia* were noted. As noteworthy features, there were the abundances of the mobile predatory and omnivorous forms along with the practically absolute absence of attached and burying animals. In our opinion, these features (as well as the absence of traces of fine sediments in the trawl) indirectly evidence strong near-bottom currents wash-



Locations of the trawl stations and the leading taxa in the estuarine zone.

ing the fine fraction off the ground. According to the data of V.A. Chechko, the upper layer of the sediments there consists of well sorted medium-grain sands. No pebbles were found in the samples from this region, which was also devoid of biofouling animals.

The last two stations of the transect (5003 and 5004) are situated already outside the zone of the direct impact of the Ob River's waters. The depths there are 60 and 150 m, and the salinity is 34.8‰ and 34.0‰, respectively. The content of organic carbon was low both in the sediments and in the near-bottom suspension. The first station is situated within the limits of the *Ohiocten sericeum* community common at the open shallows of the Kara Sea. This community is characterized by its exclusively high species diversity, which was already confirmed at the preliminary processing of the sample. Station 5004 is situated deeper (150–160 m). The large basket star *Ophiopleura borealis* dominates at this station. In terms of the composition and ratios of the leading taxa, this sample fully corresponds to the *Ophiopleura* community [7].

The distribution of the main biocenotic complexes in the studied region is shown in the figure.

CONCLUSIONS

In conclusion, at the transition from the Ob River's mouth to the open parts of the sea, consecutive changes in the bottom biocenotic complexes is observed. These changes are expressed in the changing of the leading taxa. The regularities of the changes in the crustacean communities, the communities of bivalves, and of the echinoderms [7, 3] noted earlier are true only as a rough approximation. The euryhaline representatives of all the groups listed above may deeply penetrate the Ob estuary and live in practically fresh waters.

At the same time, along with the increasing salinity, the quite clear consecutive substitution of the fresh and brackish water taxa by the relative groups adapted for living in seawater takes place. As a good example, there is the substitution of the *Saduria entomon* complex by the complex of *S. sibirica* – *S. sabini* observed at the jump of the salinity from 8.7 to 24.4‰. At the further increase in the salinity, the share of *S. sabini* gradually increases, and, in the communities of the open sea, this species remains the only one, fully forcing out the euryhaline *S. sibirica*.

Another good example is the substitution of the brackish water species of bivalve *Portlandia aestivalis* by the marine *Portlandia arctica* confined to the isohaline of about 30‰ (between the salinities of 29.5 and 32.1‰ along our transect; stations 4999 and 5000, respectively).

It is worth noting that, according to the materials of the earlier expedition aboard the R/V *Dmitrii Men-*

deleev, we were unable to delimitate the communities of *P. arctica* and *P. aestivalis*, which, according to L.A. Zenkevich, substitute each other off the Taymyr Peninsula's coast [7]. Based upon the new data, these communities are well distinguished. For the first time, the presence of a vast biocenosis quantitatively dominated by *P. aestivalis* was revealed in the Ob estuary. According to the results of the trawl sampling, mass colonies of this species occupy vast areas of the estuary up to the Belyi Island's beam in the north. In the south, the borders of these colonies may reach at least to the latitude of 72°N, as evidenced by the abundance of live mollusks at station 4996 and shell debris at station 4995.

ACKNOWLEDGMENTS

The authors are grateful to G.A. Kolyuchkin, A.A. Udalov, and F.V. Sapozhnikov for their assistance with the sampling and the processing of the initial samples; to O.N. Zezin and E.P. Turpayev for participating in the samples' processing in the laboratory; and to V.A. Chechko, P.V. Makkaveev, N.A. Belyaev, and L.L. Demina for the data presented on the composition of the sediments and the hydrochemistry of the near bottom waters.

This study was partially financially supported by the Russian Foundation for Basic Research, project nos. 09-05-13574-ofi_ts and 10-04-01683-a.

REFERENCES

1. S. V. Galkin, "Studies of Macrobenthos of the Kara Sea in Cruise 49 of R/V "Dmitrii Mendeleev",", in *Benthos of High-Latitudinal Areas*, Ed. by A. P. Kuznetsov and O. N. Zezina (IORAN, Moscow, 1998), pp. 34–41 [in Russian].
2. L. A. Zenkevich, *Fauna and Biological Productivity of the Sea* (Izd. Sov. Nauka, Moscow, 1947), Vol. 2 [in Russian].
3. L. A. Zenkevich, *Biology of Seas of the USSR* (Akad. Nauk SSSR, Moscow, 1963) [in Russian].
4. A. P. Kuznetsov, "Trophic Structure of Marine Benthic Fauna of the Kara Sea," in *Benthic Fauna of Marginal Seas of the USSR*, Ed. by A. P. Kuznetsov (IOAN, Moscow, 1976) [in Russian].
5. A. P. Kuznetsov, *Ecology of Benthic Communities of Shelf Zones of the World Ocean* (Nauka, Moscow, 1980) [in Russian].
6. V. N. Semenov, "Multiannual Changes in Biocenoses of the Benthic Fauna of the Kara Sea and Adjacent Water Areas," in *Ecology and Biological Resources of the Kara Sea* (Kol'sk. Nauchn. Tsentr AN SSSR, Apatity, 1989), pp. 145–150 [in Russian].
7. Z. A. Filatova and L. A. Zenkevich, "Quantitative Distribution of Benthic Fauna of the Kara Sea," *Tr. Vses. Hidrobiol. Obschch.* **8**, 3–62 (1957).